annual values being 89 per cent at 3 and 94 per cent at 4 kilometers. This percentage is somewhat greater in winter than in summer and at northern than at southern stations.

North component.—The data indicate that a north or south component in the surface winds persists in a majority of cases in the upper levels, except that above a surface east-northeasterly wind a south component is the more frequent and above a southwesterly or a west-southwesterly wind a north component predominates. Other features are the pronounced south component in summer, especially at southern stations, the equally pronounced north component in winter, especially at northern stations, and the resulting predominance of a south component at southern stations and of a north component at northern stations for the year.

General remarks.—The foregoing discussion of wind data and the conclusions given should be accepted with the reservation that they are based upon observations that were made only under conditions favorable for kite flying, i. e., surface winds ranging from 2 to 20 m. p. s. and upper winds ranging from 5 to 35 m. p. s. Thus it will be seen that conditions closely approaching a calm are not represented. In other words, data are lacking for days on which there was no appreciable pressure gradient. This explains the somewhat higher velocities and the slightly larger percentage frequency of a west component given in this summary than in a previous study based upon observations with pilot balloons.[8] It should be remembered, though, that pilot balloons are observed to best advantage in light winds, since they soon disappear in the distance when winds are strong. Moreover, they can not be observed at all in clouds, whereas kite flights are frequently made in cloudy weather and occasionally even when light rain or snow is falling. All things considered, then, it seems that the results obtained with kites come nearer representing all conditions than do those with balloons. In any event, they are certainly representative of the conditions that prevail most of the time, viz, moderate winds in both clear and cloudy weather.

[8] Reihle, J. A. Flying weather in the Southern Plains States. MONTHLY WEATHER REVIEW, November, 1920, 48:627-632.

RELATION BETWEEN RATE OF MOVEMENT OF ANTICYCLONES AND THE DIRECTION AND VELOCITY OF WINDS ALOFT (WEST AND SOUTHWEST OF HIGHEST PRESSURE).

By CHARLES L. MITCHELL.

[Weather Bureau, Washington, D. C., April 25, 1922.]

The importance of anticyclones in the control of weather conditions and the desirability of accurate knowledge as to whether they will move rapidly or slowly or remain practically stationary has long been recognized by forecasters. The surface conditions as shown on the daily weather maps do not always supply all the data necessary for making accurate predictions of the movement of anticyclones. It has been evident from a day-to-day inspection of the charts of wind direction and velocity at the several levels above the earth's surface at the various aerological stations of the Weather Bureau, the Army, and the Navy that the action of anticyclones depends to a large extent on the conditions shown at 2,000 to 4,000 meters, or even higher, above sea level. A study has been made, therefore, of the aerological charts of wind direction and speed in free air from pilot balloon flights from the time their preparation was begun in October, 1920, to the end of March, 1922, in connection with the rate of movement of anticyclones. In all, 62 anticyclones over the eastern half of the United States were studied, and they were classified (1) as to place of first appearance on the weather map, and (2) in relation to free-air wind direction and velocity at or above 2,000 meters to the west and southwest of the crests of the anticyclones, when available. Free-air observations below the 1,000-meter level were not considered in this study.

In general, it may be said that the rate of movement of the anticyclone is roughly proportional to the speed of the free-air winds at and above the 2,000-meter level. The results of the study are shown in the table below.

TABLE 1.—*Free-air winds and anticyclonic movement.*[1]

Winds west and southwest of crest of HIGH, usually at 2 km. to 4 km.	Type of anticyclone.			Total.
	Pacific.	Alberta or Manitoba.	Hudson Bay.	
Fresh to strong SW. winds. HIGH moved rapidly east or northeast	10	15	1	26
Same, except moderate SW. wind	0	4	1	1
Moderate SW. winds in south and fresh to strong southwest in north. Axis of HIGH changed from N.-S. to NE.-SW. Barometer fell slowly in the southeast	0	10	0	10
Fresh to strong SSW. to W winds. HIGH moved eastward with normal speed	3	8	0	11
Moderate to fresh S. and SW. in north, moderate SSE. to SSW. in south. Normal speed	1	1	0	2
Strong NW. in east and SW. from Texas northward. Deep low over Newfoundland. HIGH slow mover.	0	2	1	3
W. winds in north, SW. in south. HIGH slow mover.	1	0	0	1
Gentle to moderate SE. and S. winds. HIGH very slow mover	0	1	0	1
Fresh SW. winds. HIGH of great magnitude. Slow mover	0	2	0	2
Easterly winds aloft. Stationary HIGH	1	3	1	5
Total	16	42	4	62

[1] The term "HIGH" is used throughout this table as synonymous with "anticyclone."

In practically every case where the winds aloft were fresh to strong southwest both to the southwest and west of region of highest pressure, the anticyclone moved eastward or northeastward rapidly (in 26 instances) or at least at a normal rate of speed (in 11 instances). The only exceptions were on January 7 and March 16, 1922, when the anticyclones were of great magnitude and moved slowly eastward, although there were fresh southwest winds aloft to the west and southwest, and on October 29 and December 21, 1920, and January 2, 1922, when there was a deep stationary cyclone over Newfoundland and the winds aloft over the northeastern States were strong northwest. All of these 5 anticyclones moved slowly.

It is quite interesting to note that when Alberta or Manitoba anticyclones reach the eastern States with major axis north-south and fresh to strong southwest winds set in aloft, say from Oklahoma northward and north-eastward, but remain only moderate southwest aloft over the Gulf States, the direction of the major axis is invariably shifted from north-south to northeast-southwest, the southern end remaining almost fixed in position, i. e., pressure decreases rapidly east of the upper Mississippi Valley and a cyclone moves eastward over this region, while the barometer falls very slowly over the southeastern States and generally rises at Hamilton, Bermuda. If, at the same time, there is a deep stationary cyclone in the vicinity of Newfoundland, the northern end of the anticyclone will disappear entirely (see map of Feb. 15, 1921). This condition is peculiar to anticyclones that move southeastward from Alberta or Manitoba. One anticyclone, that of December 30, 1921, was originally tabulated as of Pacific origin, but being the only one, a further investigation was made and it was found that, while it originally appeared on the Pacific coast, it was reinforced from the Canadian Northwest on December 28, thereafter partaking of the nature of an Alberta anticyclone. It has been found from previous observation and from this study that whenever a Pacific anticyclone is reinforced by an anallobar moving down from the Canadian Northwest it becomes an Alberta anticyclone in fact; furthermore, if either a Pacific or an Alberta anticyclone is reinforced from the Hudson Bay region its future course is the same as if it came originally from that region.

It will be observed that each of the five stationary anticyclones was very deep and controlled the upper winds far to the westward. A striking example was the anticyclone of the last week in October, 1921, the note made in connection with it being as follows:

October 25.—Anticyclone 30.3 [inches] over Ontario. Moderate to fresh east and southeast winds aloft from Lansing and Royal Center westward. Gentle southwest winds in west Gulf States. Anticyclone moved slowly southeastward over northeastern States, then remained stationary with lessening intensity until end of month. Stationary cyclone over Newfoundland. Winds aloft remained southeast to northeast at Royal Center during entire period and two Colorado disturbances of marked intensity were retarded, partially filled up, and diverted from normal path.

As a result of this study and of the day-to-day examination of the aerological charts the writer is convinced that, given sufficient upper-air observations, the forecaster can predict with a great deal of confidence the future course and the rate of movement of practically every anticyclone.

HIGH-LEVEL ISOBARS AS USED IN EVERY-DAY WEATHER SERVICE.

By RIKICHI SEKIGUCHI.

[Cambridge, England, Apr. 5, 1922.]

NOTE.—Through the courtesy of Prof. V. Bjerknes, Doctor Sekiguchi has kindly prepared for the REVIEW the paper which he delivered before the International Commission for the investigation of the Upper Air held at Bergen, Norway, July 25-30, 1921.[1] Doctor Sekiguchi has had extensive experience in the application of maps of free-air pressure[2] to forecasting in Japan.—EDITOR.

The present communication is a short summary of the author's two years' experience in his weather service, in cooperation with Dr. S. Fujiwhara and Dr. Y. Horiguchi, at Osaka and Kobe. Several trials in the use of high-level isobars were made with the hope of finding some help for predicting the change of weather type with greater certainty than the ordinary synoptic charts alone can afford. At first (the spring of 1918), the 1,000-meter level was chosen for daily use and proved itself very useful in predicting movements of cyclonic centers. Later on, charts for the 3,000-meter level were added to the scheme and even 6,000-meter isobars were drawn occasionally. But after some experience having found the 3,000-meter chart most useful, the author confined his attention mainly to that level.

In drawing isobars, the values of pressure on the respective levels must be entirely based on the observed surface values of certain meteorological elements and certain assumptions concerning the lapse rate of temperature. The method of drawing isobars had nothing different from that which is being generally used in making ordinary synoptic charts, except that on the high levels there was no information concerning the wind to be taken into account in checking the trend of isobars, as is usually done on the sea-level chart.

At first the complexity of the trend of the isobars as influenced by local abnormality of surface air temperatures was a perplexing feature. But as the author became somewhat experienced in this method he could get rid of this complexity to some extent by making due allowances for the abnormalities that might be estimated to some degree from the topographic conditions, temperature changes, the state of the sky, etc. After some study it has been found that the general trend of the upper isobars in general was not so much affected by the actual lapse rate being unknown as it was at first feared. The remaining abnormalities seemed to have caused no great disturbances in considering the general trend of isobars in the majority of cases. Moreover, for the sake of safety, the high-level charts were based on the data from coast stations only, as far as it was possible, in view of minimizing the effect of surface inversion. Some of the results of investigations are summarized as follows:

(1) The movements of cyclonic centers in the Far East showed in most cases fair accordance with the general trend of the 3,000-meter isobars,[3] showing the less dependence upon the trend of sea-level isobars.

(2) The region where the general trend of both systems of isobars (free-air and sea-level) ran nearly parallel to each other was never passed by a cyclone which happened to be in the neighborhood at that moment. This fact seems to be in fair accord with the current idea that cyclones tend to be drifted by the prevailing upper-air current, if the upper isobars are assumed as identical with the stream lines on that level.

(3) When both systems of isobars ran nearly parallel on three sides—that is, on the front, right, and left—of the path of the cyclone, that cyclone was observed to be generally stationary. Similar phenomena were almost invariably observed when the wedges of high pressure

[1] Cf. *Proceedings*, p. 23.
[2] Cf. Fujiwhara, S.: Pressure maps at 3 kilometers in Japan. MO. WEATHER REV., Oct., 1921.

[3] Mr. C. L. Mitchell points out numerous similar cases where anticyclonic movement in the United States was in agreement with the direction and speed of upper currents. This REVIEW, pp. 241-242. EDITOR.